

CLAIMS:

1. A spatial information detecting apparatus using intensity-modulated light comprising:

- 5 at least one photoelectric converter for receiving a light provided from a space, into which a light intensity-modulated by a predetermined modulation signal is being irradiated, and generating amounts of electric charges corresponding to an intensity of received light;
- charge discarding means having a first electrode for removing dispensable charges from the electric charges generated by said photoelectric converter according to a voltage applied to said first electrode;
- 10 charge storage means for storing signal charges from the electric charges generated by said photoelectric converter;
- a control circuit for controlling the voltage applied to said first electrode at a timing synchronized with a period of said modulation signal to change a ratio of the signal charges stored in said charge storage means to the electric charges generated by said photoelectric converter;
- 15 a charge ejector for outputting the signal charges from said charge storage means; and
- 20 an analyzer for determining spatial information from an output of said charge ejector.

2. The spatial information detecting apparatus as set forth in claim 1, wherein said charge storage means has a second electrode, and said control circuit controls a voltage applied to said second electrode constant to transfer required amounts of the electric charges generated by said photoelectric converter to said charge storage means.

3. The spatial information detecting apparatus as set forth in claim 2, wherein said control circuit controls the voltages applied to said first electrode and said second electrode so as to alternately switch between a stage of transferring the electric charges generated by said photoelectric converter to said charge storage means and a stage of transferring the electric charges generated by said photoelectric converter to said charge discarding means.

10 4. A spatial information detecting apparatus using intensity-modulated light comprising:

at least one photoelectric converter for receiving a light provided from a space, into which a light intensity-modulated by a predetermined modulation signal is being irradiated, and generating amounts of electric charges corresponding to an intensity of received light;

charge discarding means having a first electrode for removing dispensable charges from the electric charges generated by said photoelectric converter according to a voltage applied to said first electrode;

charge storage means having a second electrode for storing signal charges from the electric charges generated by said photoelectric converter according to a voltage applied to said second electrode;

a control circuit for controlling the voltage applied to said second electrode at a timing synchronized with a period of said modulation signal, while applying a constant voltage to said first electrode, to change a ratio of the signal charges stored in said charge storage means to the electric charges generated by said photoelectric converter;

a charge ejector for outputting the signal charges from said charge storage means; and

an analyzer for determining spatial information from an output of said charge

ejector.

5. The spatial information detecting apparatus as set forth in claim 1, wherein said
5 at least one photoelectric converter is a plurality of photoelectric converters, and
the spatial information detecting apparatus includes a CCD image sensor having
said photoelectric converters, said charge storage means and said charge ejector,
and wherein said CCD image sensor has an overflow drain as said charge
discarding means.

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- 6 The spatial information detecting apparatus as set forth in claim 1, wherein said
at least one photoelectric converter is a plurality of photoelectric converters,
a set of photoelectric converters is selected from said photoelectric
15 converters to define one pixel,
said control circuit allows said charge storage means to store the signal
charges from the electric charges generated by each of said photoelectric
converters of the set at a timing of each of different phases in synchronization
with the period of said modulation signal, and wherein
20 said charge ejector simultaneously outputs the signal charges stored with
respect to the different phases.

7. The spatial information detecting apparatus as set forth in claim 2, wherein said
25 charge storage means has a light shielding film on said second electrode formed
in the vicinity of a region of storing the signal charges.

8. The spatial information detecting apparatus as set forth in claim 1, wherein said

analyzer determines a phase difference between the light irradiated into the space and the light received by said photoelectric converter from the signal charges stored with respect to different phases of said modulation signal.

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9. The spatial information detecting apparatus as set forth in claim 8, wherein said analyzer converts said phase difference into distance information.

10 10. The spatial information detecting apparatus as set forth in claim 1, wherein
said analyzer determines distance information from the signal charges stored with
respect to different phases in a period of said modulation signal, and wherein the
spatial information detecting apparatus further comprises a phase switch for
changing the phase of said modulation signal, at which the voltage is applied to
15 said first electrode, every time that storing the signal charges in said charge
storage means at the phase is finished.

11. A spatial information detecting method using a CCD image sensor having an
overflow drain electrode comprising the steps of:
allowing said CCD image sensor to receive a light provided from a space, into
which a light intensity-modulated by a predetermined modulation signal is being
irradiated;
storing signal charges by repeating a charge extraction operation plural times with
20 respect to each of different phases in a period of said modulation signal; and
determining spatial information from the signal charges stored with respect to the
different phases of said modulation signal,

wherein said charge extraction operation includes the steps of removing
dispensable charges from electric charges generated by photoelectric converters

of said CCD image sensor according to a control voltage applied to said overflow electrode in synchronization with the period of said modulation signal, and storing the balance of the electric charges as the signal charges in a charge storage area of said CCD image sensor.

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12. The spatial information detecting method as set forth in claim 11, wherein said CCD image sensor is an interline transfer CCD image sensor.

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13. The spatial information detecting method as set forth in claim 11, wherein said CCD image sensor is a frame transfer CCD image sensor.

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14. The spatial information detecting method as set forth in claim 13, wherein said CCD image sensor has at least three photoelectric converters, and said charge extraction operation includes the step of applying the control voltage to said overflow drain electrode in synchronization with the period of said modulation signal such that the electric charges generated by a predetermined one(s) of said at least three photoelectric converters are stored as the signal charges in said charge storage area, and the electric charges generated by the remaining photoelectric converter(s) are discarded as the dispensable charges.

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15. The spatial information detecting method as set forth in claim 14, wherein the control voltage is applied to said overflow drain electrode to generate a potential barrier for electrically isolating the predetermined photoelectric converter(s) from the remaining photoelectric converter(s).

16. A light receiving element with controllable sensitivity comprising:
 - at least one photoelectric converter for receiving a light provided from a space, into which a light intensity-modulated by a predetermined modulation signal is being irradiated, and generating amounts of electric charges corresponding to an intensity of received light;
 - charge discarding means having an electrode for removing dispensable charges from the electric charges generated by said photoelectric converter according to a voltage applied to said electrode;
- 10 charge storage means for storing signal charges from the electric charges generated by said photoelectric converter;
- a sensitivity controller for controlling the voltage applied to said electrode at a timing synchronized with a period of said modulation signal to change a ratio of the signal charges stored in said charge storage means to the electric charges generated by said photoelectric converter; and;
- 15 a charge ejector for outputting the signal charges from said charge storage means.